Faculty Engineering Technology
Program Sustainable Energy Technology

UNIVERSITY OF TWENTE.

COLLOQUIUM

Group: **Engineering Fluid Dynamics**

As part of her MSc thesis assignment

S.L. Kooreman

will give a presentation, entitled:

Wall Condensation of an Air-Vapour Mixture on a Cylindrical Pin

Date: Friday January 10, 2014

Time: 14:00

Room: NH 209

Summary:
Wall condensation on a pin occurs when the temperature of the pin surface is below the saturation temperature. During condensation, latent heat is released. For the use of cylindrical pin fins in a heat exchanger, this is a favourable process because the rate of heat transfer is augmented by the latent heat transfer, which increases the energy efficiency of the heat exchanger.
This will reduce the required amount of fossil fuel, in this research natural gas. Increasing the energy efficiency of a heat exchanger also facilitates the use of biogas in heat exchangers, compensating for biogases having a lower caloric value than natural gas. The goal of this study is to identify and resolve obstacles for latent heat transfer in the flue gas channel of heat exchangers.

The condensing flow of an air-vapour mixture over a cylindrical pin is numerically simulated using the commercial CFD package ANSYS CFX. First a 2D model flow is considered of dry air without condensation. As a validation of the results of the numerical simulations, flow and heat transfer variables are compared with empirical correlations. The numerically obtained solutions are found to be in good agreement with results from these empirical correlations. Following the validation of the method for the case of dry air, the flow of an air-vapour mixture has been investigated. In such a flow a diffusion boundary layer forms at the cylinder surface in which the mass fractions of air and vapour affect the latent heat transfer. The representation of this effect requires to add the conservation equation of mass species to the mass-, momentum- and energy equations for the mixture.

The results of the numerical simulations show that the diffusion boundary layer hinders latent heat transfer. The presence of non-condensable air molecules at the surface forms a partial blockage for the condensable vapour molecules. In literature it is suggested that increasing the free stream velocity will enhance the diffusion process in removing air from and supplying vapour to the surface. The results of the numerical simulations indeed show an increase of the latent heat transfer coefficient with increasing free stream velocity. Another effect becoming apparent in the numerical results is the effect of vortex shedding from the pin on the latent heat transfer coefficient. The latent heat transfer coefficient is shown to increase due to recirculation in the vortex shedding wake.

Assessment committee:

Prof.dr.ir. H.W.M. Hoeijmakers	(chairman)
Ir. M. van der Wiel	(mentor)
Prof.dr.ir. T.H. van der Meer	
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d.d. 19 december 2013